

Distribution of molecular solutes in phase-separated systems containing charged macromolecules

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Phase separation occurs spontaneously in aqueous systems which contain macromolecules with oppositely charged groups. In synthetic polyelectrolytes, this process yields a condensed polymer-rich phase, termed polyelectrolyte complex, and a polymer-poor phase, termed supernatant. In biomolecular systems, the same process yields biomolecular condensates, which often form liquid-like droplets. In this lecture, we discuss how the charge of solutes determines their distribution between the condensed polymer-rich phase and the supernatant. We show that while monovalent ions distribute quite evenly between both phases, the multivalent ones prefer the condensed phase, even if it contains an excess of macromolecules which have the same charge as the solute. The latter observation seemingly contradicts the Donnan theory but can be explained by explicitly considering the effect of electrostatic interactions between the solute and the condensate. Finally, we show that the distribution of oligomeric solutes is determined not only by their net charge but also by how the charges are distributed on the solute.

Keywords:

polyelectrolyte, coacervate, condensate, phase-separation